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Numerical Reconstruction of Three-Dimensional Sigmoidal Structure Associated with Flux Emergence on the Sun

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The sigmoidal structure observed above the neutral line before a solar flare has been widely believed to be a candidate storing free energy. We can also consider that the sigmoidal structure can be used to predict soar active phenomena. Therefore, the understanding of three-dimensional sigmoidal structure is very important for predicting the onset of a flare, which contributes to space weather forecast. Because magnetic field is measured only on the solar surface, we cannot obtain the information on three-dimensional structure of magnetic field.

In this paper, we report the result of three-dimensional sigmoidal structure obtained by Non-Linear Force-Free (NLFF) extrapolation method. Since our purpose is to investigate the validity of the NLFF extrapolation method under a dynamic situation as like real solar atmosphere, a reference model is needed. The model is obtained from MHD simulation (Magara, 2004,2006) , which produces three-dimensional sigmoidal structure of current density when a twisted flux tube embedded in the convection zone is emerging to the solar corona.

As a result of NLFF extrapolation, we found that the strong current region near the solar surface is captured by NLFF extrapolation, whereas the upper part of coronal field cannot be reproduced well. In other words, the NLFF extrapolation can reproduce the energy stored region causing solar active phenomena, which is located at the lower part of coronal field. The reconstructed NLFF field reproduces about 80% of the magnetic energy produced by the reference model. We will discuss the effects of the stratification of the background atmosphere and the twist of an emerging flux tube.